JAPAN

EDICT OF GOVERNMENT

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JIS B 9716 (2006) (English): Safety of machinery -- Guards -- General requirements for the design and construction of fixed and movable guards

ISO INSIDE

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The citizens of a nation must honor the laws of the land.

Fukuzawa Yukichi

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JIS

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STANDARD

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Safety of machinery—Guards—General requirements for the design and construction of fixed and movable guards

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In the event of any doubts arising as to the contents,
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Contents

Foreword

This translation has been made based on the original Japanese Industrial Standard established by the Minister of Health, Labour and Welfare and the Minister of Economy, Trade and Industry through deliberations at the Japanese Industrial Standards Committee according to the proposal of establishing a Japanese Industrial Standard from the Japan Machinery Federation (JMF), with a draft being attached, based on the provision of Article 12 Clause 1 of the Industrial Standardization Law.

Attention is drawn to the possibility that some parts of this Standard may conflict with a patent right, application for a patent after opening to the public, utility model right or application for registration of utility model after opening to the public which have technical properties. The relevant Ministers and the Japanese Industrial Standards Committee are not responsible for identifying the patent right, application for a patent after opening to the public, utility model right or application for registration of utility model after opening to the public which have the said technical properties.

Safety of machinery—Guards—General requirements for the design and construction of fixed and movable guards

Introduction

This Japanese Industrial Standard has been prepared based on **ISO 14120** published in 2002 without modifying the technical contents.

This Standard specifies general principles for the design and construction of guards, both fixed and movable. It is intended for use by manufacturers, designers, standards makers and other interested parties.

As a Type-B2 standard, it is intended to provide assistance in the production of Type-C standards which cover detailed aspects for specific groups of machines, and to provide guidance in the absence of an appropriate Type-C standard.

In accordance with the requirements laid down in **JIS B 9700-1** : 2004 and **JIS B 9700-2** : 2004, the machine designer shall identify the hazards present at a machine, carry out a risk assessment and reduce risk by design before considering safeguarding techniques.

1 Scope

This Standard specifies general requirements for the design and construction of guards provided primarily to protect persons from mechanical hazards.

This Standard applies primarily to machines which will be manufactured after it is published.

Attention is drawn to the use of guards to minimize exposure to non-mechanical hazards.

The requirements are applicable if fixed and movable guards are used. This Standard does not cover those parts of guards which actuate interlocking devices. These are covered in **JIS B 9710** : 2006.

This Standard does not provide requirements for special systems relating specifically to mobility or to the ability to lift loads such as rollover protective structures (ROPS) and falling-object protective structures (FOPS).

NOTE : The International Standard corresponding to this Standard is as follows.

ISO 14120 : 2002 *Safety of machinery—Guards—General requirements for the design and construction of fixed and movable guards* (IDT)

In addition, symbols which denote the degree of correspondence in the contents between the relevant International Standard and **JIS** are IDT (identical), MOD (modified), and NEQ (not equivalent) according to **ISO/IEC Guide 21**.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this Standard. If the indication of the year is given to the referred standard, the edition of indicated year applies but the revision (including amendments) made thereafter does not apply.

JIS B 9700-1 : 2004 *Safety of machinery—Basic concepts, general principles for design—Part 1: Basic terminology, methodology*

NOTE : Corresponding International Standard: **ISO 12100-1** : 2003 *Safety of machinery—Basic concepts, general principles for design—Part 1: Basic terminology, methodology* (IDT)

JIS B 9700-2 : 2004 *Safety of machinery—Basic concepts, general principles for design—Part 2: Technical principles*

NOTE : Corresponding International Standard: **ISO 12100-2** : 2003 *Safety of machinery—Basic concepts, general principles for design—Part 2: Technical principles* (IDT)

JIS B 9702 : 2000 *Safety of machinery—Principles of risk assessment*

NOTE : Corresponding International Standard: **ISO 14121** : 1999 *Safety of machinery—Principles of risk assessment* (IDT)

JIS B 9707 : 2002 *Safety of machinery—Safety distances to prevent danger zones being reached by the upper limbs*

NOTE : Corresponding International Standard: **ISO 13852** : 1996 *Safety of machinery—Safety distances to prevent danger zones being reached by the upper limbs* (IDT)

JIS B 9708 : 2002 *Safety of machinery—Safety distances to prevent danger zones being reached by the lower limbs*

NOTE : Corresponding International Standard: **ISO 13853** : 1998 *Safety of machinery—Safety distances to prevent danger zones being reached by the lower limbs* (IDT)

JIS B 9709-1 : 2001 *Safety of machinery—Reduction of risks to health from hazardous substances emitted by machinery—Part 1: Principles and specifications for machinery manufacturers*

NOTE : Corresponding International Standard: **ISO 14123-1** : 1998 *Safety of machinery—Reduction of risks to health from hazardous substances emitted by machinery—Part 1: Principles and specifications for machinery manufacturers* (IDT)

JIS B 9710 : 2006 *Safety of machinery—Interlocking devices associated with guards—Principles for design and selection*

NOTE : Corresponding International Standard: **ISO 14119** : 1998 *Safety of machinery—Interlocking devices associated with guards—Principles for design and selection* (IDT)

JIS B 9711 : 2002 *Safety of machinery—Minimum gaps to avoid crushing of parts of the human body*

NOTE : Corresponding International Standard: **ISO 13854**: 1996 *Safety of machinery—Minimum gaps to avoid crushing of parts of the human body* (IDT)

JIS B 9960-1 : 1999 *Safety of machinery—Electrical equipment of machines—Part 1: General requirements*

NOTE : Corresponding International Standard: **IEC 60204-1** : 1997 *Safety of machinery—Electrical equipment of machines—Part 1: General requirement* (MOD)

3 Terms and definitions

For the purposes of this Standard, the terms and definitions given in **JIS B 9700-1**: 2004 and the following apply.

3.1 guard

part of a machine specifically used to provide protection by means of a physical barrier

NOTE 1 A guard may act:

— alone, in which case it is only effective when it is closed;

— in conjunction with an interlocking device with or without guard locking, in which case protection is ensured whatever the position of the guard (see also **3.5**).

NOTE 2 Depending on its construction, a guard may be called casing, cover, screen, door, enclosing guard, etc.

NOTE 3 See **JIS B 9700-2** : 2004, **5.3.2** and this Standard for the classification of guards and requirements.

(See **JIS B 9700-1** : 2004, **3.25**)

3.2 fixed guard

guard kept in place, that is closed, either permanently (by welding, etc.), or by means of fasteners (screws, nuts, etc.) making removal/opening impossible without using tools

(See **JIS B 9700-1** : 2004, **3.25.1**)

3.2.1 enclosing guard

guard which prevents access to the danger zone from all sides

See figure 1.

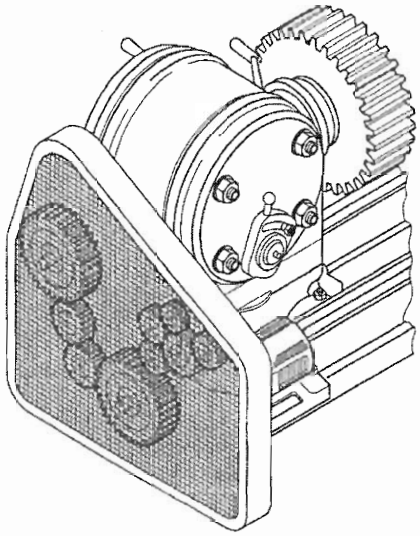


Figure 1 Example of an enclosing guard totally preventing access to transmission machinery

3.2.2 distance guard

guard which does not completely enclose a danger zone, but which prevents or reduces access by virtue of its dimensions and its distance from the danger zone, for example perimeter fence or tunnel guard

See figures 2 and 3.

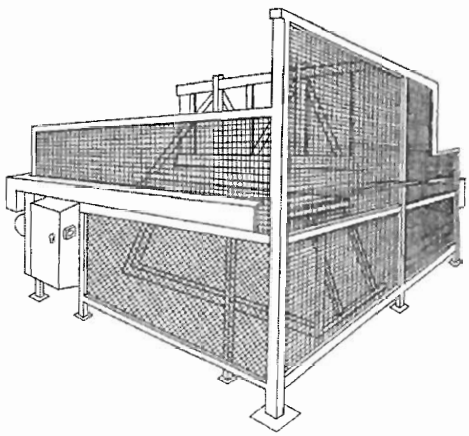


Figure 2 Example of a distance guard

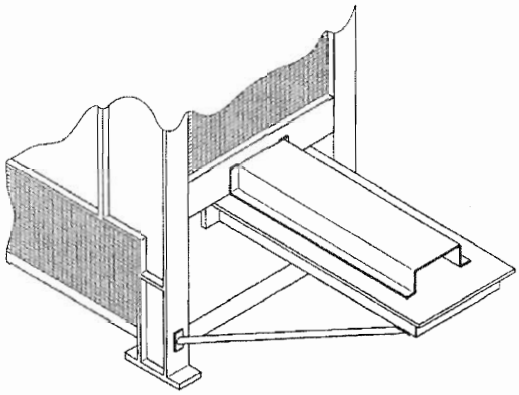


Figure 3 Example of a distance guard: tunnel guard providing protection at machine feed or discharge area

3.3 movable guard

guard generally connected by mechanical means, for example with hinges or slides, to the machine frame or an adjacent fixed element and which can be opened without the use of tools

(See **JIS B 9700-1** : 2004, **3.25.2**)

3.3.1 power-operated guard

movable guard that is operated with the assistance of power from a source other than persons or gravity

3.3.2 self-closing guard

movable guard operated by a machine element (for example a moving table) or by the workpiece or a part of the machining jig, so that it allow the workpiece (and the jig) to pass and then automatically returns (by means of gravity, a spring, other external power, etc.) to the closed position as soon as the workpiece has vacated the opening through which it has been allowed to pass

See figure 4.

3.3.3 interlocking guard with a start function, control guard

special form of an interlocking guard which, once it has reached its closed position, gives a command to initiate the hazardous machine function(s) without the use of a separate start control

(in accordance with **JIS B 9700-1** : 2004, **3.25.6**)

NOTE : The use of control guards is subject to certain conditions (see **5.4.9**).

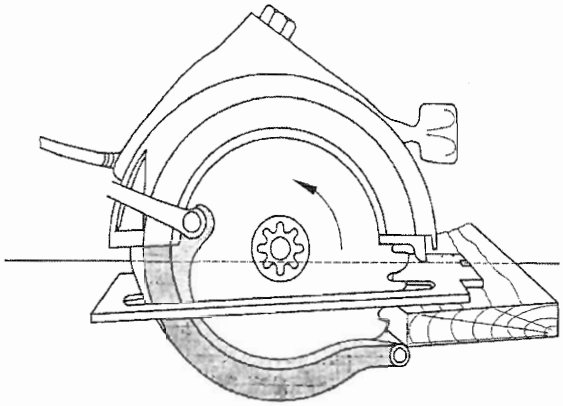


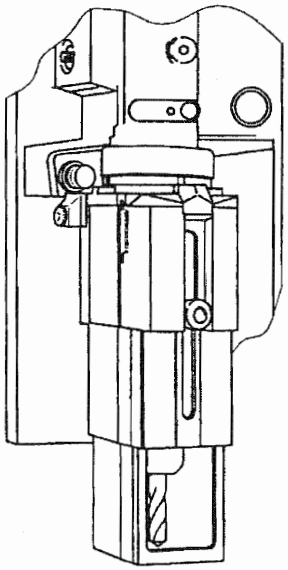
Figure 4 Example of a self-closing guard

3.4 adjustable guard

fixed or movable guard which is adjustable as a whole or which incorporates adjustable parts

The adjustment remains fixed during a particular operation (see **JIS B 9700-1** : 2004, **3.25.3**).

See figure 5.



The guard is telescopic to provide ready adjustment to the surface of the workpiece, and it is attached to a hinge to permit access to the spindle for drill changing.

Figure 5 Example of an adjustable guard for a radial or pedestal drilling machine

3.5 interlocking guard

guard associated with an interlocking device so that:

— the hazardous machine functions "covered" by the guard cannot operate until the guard is closed;

— if the guard is opened while hazardous machine functions are operating, a stop instruction is given;

— when the guard is closed, the hazardous machine functions "covered" by the guard can operate, but the closure of the guard does not by itself initiate their operation

NOTE : See **JIS B 9710** : 2006 for the details.

(See **JIS B 9700-1** : 2004, **3.25.4**)

See figures 6 and 7.

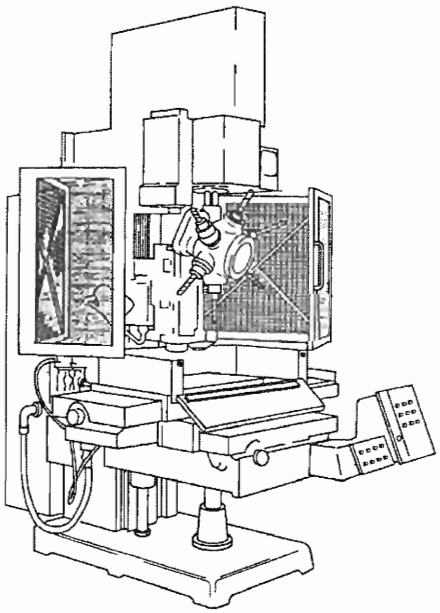


Figure 6 Example of interlocking hinged guards; these enclose the danger zone when closed

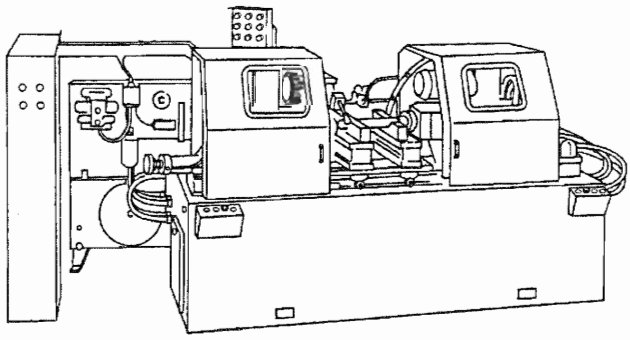


Figure 7 Example of interlocking sliding guards

3.6 interlocking guard with guard locking

guard associated with an interlocking device and a guard locking device so that:

— the hazardous machine functions "covered" by the guard cannot operate until the guard is closed and locked;

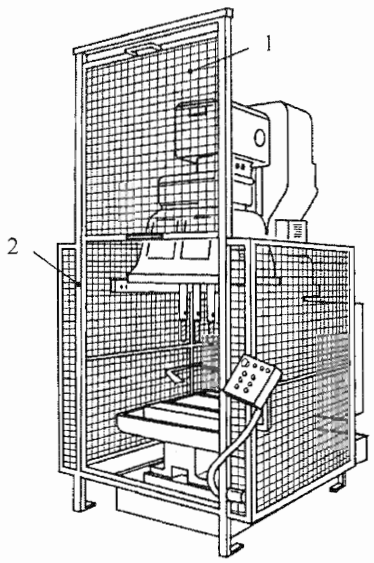
— the guard remains closed and locked until the risk of injury from the hazardous machine functions has passed;

— when the guard is closed and locked, the hazardous machine function "covered" by the guard can operate, but the closure and locking of the guard do not by themselves initiate their operation.

NOTE : See **JIS B 9710** : 2006 for the details.

(See **JIS B 9700-1** : 2004, **3.25.5**)

See figure 8.



Key

1 Interlocking guard in the open position

2 Example of guard locking device

Figure 8 Example of safeguarding of drilling machine using interlocking guards with guard locking and fixed guards

3.7 guard closed position

when performing the function for which it was designed, that is to prevent or reduce access to the danger zone and/or reduce exposure to hazards such as noise, radiation etc., a guard is closed

3.8 guard open

when it is not in the closed position, a guard is open

3.9 tool

implement such as a key or wrench designed to operate a fastener

An improvised implement such as a coin or a nail-file cannot be considered as a tool.

3.10 use of a tool

use of a tool by an authorized person under known and predetermined circumstances as part of a safe system of work

3.11 frequency of access

number of occasions on which access is required or foreseeable within the guarded area per unit of time

4 Risk assessment

In order to select and design types of guards appropriate to particular machinery, it is important to assess the risk arising from the various hazards present at that machinery and the foreseeable categories of persons at risk (see **JIS B 9700-1** : 2004, clause **5** and **JIS B 9702** : 2000).

5 Principal requirements for the design and construction of guards

5.1 Machine aspects

5.1.1 General

Proper consideration of foreseeable aspects of the machine environment and operation throughout the foreseeable life of the machine is necessary in the design and application of guards. Inadequate consideration of these aspects can lead to unsafe or inoperable machinery. This in turn can lead persons to defeat the guards provided, thus exposing them to greater risk.

5.1.2 Access to danger zones

To minimize access to danger zones where practicable, guards and machinery shall be so designed as to enable routine adjustments, lubrication and maintenance to be carried out without opening or removing the guards.

Where access is required within the guarded area, this shall be as free and unobstructed as practicable. The following are examples of reasons for access:

— loading and unloading;

— tool changing and setting;

— measurement, gauging and sampling;

— process observation;

— maintenance and repair;

— lubrication;

— removal of waste material (for example scrap, swarf, spillage);

— obstruction removal;

— cleaning and hygiene.

5.1.3 Containment of ejected parts

Where there is a foreseeable risk of ejection of parts (for example broken tooling, workpiece) from the machine, the guard shall, as far as practicable, be designed and constructed from appropriate materials selected to contain such ejections.

5.1.4 Containment of hazardous substances

Where there is a foreseeable risk of emission from the machine of hazardous substances (for example coolant, vapours, gases, swarf, sparks, hot or molten material, dust), the guard shall be designed to contain these substances as far as practicable and suitable extraction equipment can be needed (see **JIS B 9709-1** : 2001).

If a guard forms part of an extraction system, this function shall be considered in the design, selection of materials, construction and positioning of the guard.

5.1.5 Noise

Where a requirement has been established to reduce machine noise, guards shall be designed and constructed to give the required noise reduction whilst providing protection against the other hazards present at the machine (see Bibliography [4]). Guards acting as acting as acoustic enclosures shall have adequately sealed joints to reduce the emission of noise.

5.1.6 Radiation

Where there is a foreseeable risk of exposure to hazardous radiation, guards shall be designed and appropriate materials selected to protect persons from the hazard. Examples include the use of darkened glazing to prevent weldflash or the elimination of openings in a guard around a laser.

5.1.7 Explosion

Where there is foreseeable risk of explosion, guards shall be designed to contain or dissipate the released energy in a safe manner and direction (for example by use of "explosion relief" panels) (see Bibliography [13]).

5.2 Human aspects

5.2.1 General

Reasonably foreseeable aspects of human interaction with machinery (for example when loading, maintaining or lubricating) shall be given proper consideration in the design and construction of guards.

5.2.2 Safety distances

Guards intended for preventing access to danger zones shall be designed, constructed and positioned to prevent parts of the body from reaching danger zones (see also **JIS B 9707** : 2002 and **JIS B 9711** : 2002).

5.2.3 Control of access to the danger zone

As far as is practicable, movable guards shall be designed and positioned such that during normal operation they are prevented from closing with persons in the

danger zone. Where this is not practicable, other means shall be used to prevent persons from remaining undetected within the danger zone.

5.2.4 Viewing

To minimize the need to remove them, guards shall be designed and constructed to offer adequate viewing of the process.

5.2.5 Ergonomic aspects

Guards shall be designed and constructed taking into account ergonomic principles (see also **JIS B 9700-2** : 2004, **4.8.2** and **4.8.3**)

5.2.5.1 Size and weight

Removable sections of guards shall be designed to be of a suitable size and weight to permit ease of handling. Guards which cannot readily be moved or transported by hand shall be provided or be capable of being provided with suitable attachment devices for transport by means of a lifting gear.

The attachments or provisions can be, for instance:

— standard lifting appliances with slings, hooks, eyebolts or simply tapped holes for appliance fixing;

— appliances for automatic grabbing with a lifting hook, when securing is not possible from the ground;

— lifting gear and appliances integrated into the guard;

— an indication, on the guard itself and on some of its removable parts or in the information for use, of the value of their mass expressed in kilograms (kg).

5.2.5.2 Operating force

Movable guards or removable sections of guards shall be designed to permit ease of operation.

The observance of ergonomic principles in designing guards contributes to increasing safety by reducing stress and the physical effort of the operator. This improves the performance and reliability of the operation, thereby reducing the probability of errors at all stages of machine use (see **JIS B 9700-1** : 2004, **5.3**).

Operating forces can be reduced by the use of devices such as springs, counterbalances or gas struts.

Where guards are power operated, they shall not be capable of causing injury (for example from contact pressure, force, speed, sharp edges). Where a guard is fitted with a protective device which automatically initiates re-opening of the guard, the force to prevent the guard closing shall not exceed 150 N. The kinetic energy of the guard shall not exceed 10 J. Where no such protective device is fitted, these values shall be reduced to 75 N and 4 J respectively.

5.2.6 Intended use

Guards shall be designed so far as is practicable to take into account foreseeable use and reasonably foreseeable misuse (see **JIS B 9700-1** : 2004, **3.22**).

5.3 Guard design aspects

5.3.1 General

All foreseeable aspects of guard operation shall be given proper consideration at the design stage to ensure that the design and construction of the guard itself does not create a further hazard.

5.3.2 Crushing or trapping points

Guards shall be designed so as not to cause hazardous crushing or trapping points with parts of the machine or other guards (see also **JIS B 9711** : 2002).

5.3.3 Durability

Guards shall be designed to perform their function properly throughout the foreseeable life of the machine, otherwise provision shall be made for the replacement of degradable parts.

5.3.4 Hygiene

Where applicable, guards shall be designed so as not to create hazards to hygiene by trapping items or material, for example food particles, stagnant fluids (see Bibliography [14]).

5.3.5 Cleaning

Guards used in certain applications, notably for the processing of food and pharmaceuticals, shall be so designed that they are not only safe to use but can also be easily cleaned.

5.3.6 Exclusion of contaminants

Where it is a requirement of the process, guards shall be designed to exclude contaminants from the process, for example in the food, pharmaceutical, electronic and related industries.

5.4 Guard construction aspects

The following aspects shall be considered in determining the methods to be used for the construction of guards.

5.4.1 Sharp edges, etc.

Guards shall be constructed so as to be free of exposed sharp edges, corners or other hazardous projections.

5.4.2 Integrity of joints

Welded, bonded or mechanically fastened joints shall be of sufficient strength to suit reasonably foreseeable loading. Where bonding agents are used, these shall be compatible with the process and materials being used. Where mechanical fastenings are used, their strength, number and spacing shall be sufficient to ensure the stability and rigidity of the guard.

5.4.3 Removal only by tool

Demountable parts of guards shall only be removable with the aid of a tool (see **3.9** and **3.10**).

5.4.4 Positive location of removable guards

Where practicable, removable guards shall be unable to remain in place without their fixings.

5.4.5 Positive closing of movable guards

The closed position of movable guards shall be determined positively. The guard shall be held in position against a stop by means of gravity, a spring, catch, guard locking device or other means.

5.4.6 Self-closing guards

The self-closing guard opening shall be limited to no more than that required for the passage of the workpiece. It shall not be possible to block the guard in its open position. These guards can be used in conjunction with fixed distance guards.

5.4.7 Adjustable guards

Adjustable parts shall be such as to enable the opening to be restricted to a minimum consistent with the passage of material, and be easily adjustable without the use of a tool.

5.4.8 Movable guards

The opening of movable guards shall require positive action and, where practicable, movable guards shall be attached to the machine or adjacent fixed elements so that they are retained, for example by hinges or slides, even when open. Such attachments shall only be removable with the aid of a tool (see **3.9** and **3.10**).

5.4.9 Control guards

Control guards (see **3.3.3** and **JIS B 9700-2** : 2004, **5.3.2.5**) may be used only if all the following conditions are fulfilled:

— there is no possibility for an operator or a part of his body to remain in the danger zone or between the danger zone and the guard while the guard is closed;

— the dimensions and shape of the machine allow for the operator or any person having to intervene on the machine to have a global view of the whole machine/process;

— opening the control guard or an interlocking guard is the only way to enter the danger zone;

— the interlocking device associated with the control guard is of the highest possible reliability (as its failure can lead to an unintended/unexpected start-up);

— where starting the machine with a control guard is one of the possible control modes of the machine, mode selection shall be ensured (see Bibliography [15]).

NOTE : The danger zone considered above is any zone where the operation of hazardous elements is initiated by closure of the control guard.

5.5 Selection of materials

5.5.1 General

The following aspects shall be considered in the selection of suitable materials for the construction of guards. These properties shall be maintained throughout the foreseeable life of the guard.

5.5.2 Impact resistance

Guards shall be designed to withstand reasonably foreseeable impacts from parts of machinery, workpiece, broken tooling, ejected solid or fluid matter, impact by the operator, etc. Where guards are fitted with viewing panels, special consideration shall be given to the selection of materials and method of fixing them. Materials shall be selected with properties suited to resist the mass and velocity of the ejected object or material.

5.5.3 Rigidity

Support posts, guard frames and infill materials shall be selected and arranged to provide a rigid and stable structure and to resist deformation. This is especially important where deformation of material could be detrimental to maintaining safety distances.

5.5.4 Secure fixing

Guards or parts of guards shall be secured by fixing points of adequate strength, spacing and number to remain secure under any foreseeable loading. Fixing can be by means of mechanical fasteners or clamps, welded or bonded joints or other means suited to the application.

5.5.5 Reliability of moving parts

Moving parts, for example hinges, slides, handles, catches, shall be selected to ensure reliable operation given their foreseeable usage and working environment.

5.6 Containment

Harmful substances, for example fluids, swarf, dust, fumes, which can reasonably be foreseen, shall be contained within the guard by a suitable impermeable material.

5.7 Resistance to corrosion

Materials shall be selected which are resistant to foreseeable oxidation and corrosion from the product, process or environmental factors, for example from cutting fluids in machining operations or cleaning and sterilizing agents in food processing machinery. This can be achieved by the application of suitable protective coatings.

5.8 Resistance to micro-organisms

Where there is a foreseeable risk to health from bacterial and fungal growth, such as in the food, pharmaceutical and related industries, materials used in the construction

of guards shall be selected that inhibit this growth and can be easily cleaned and, if necessary, disinfected.

5.9 Non-toxicity

Materials and finishes used shall be non-toxic in all foreseeable conditions of use and compatible with the process involved especially in food, pharmaceutical and related industries.

5.10 Machine viewing

Where viewing of machine operation is required through the guard, materials shall be selected with suitable properties, for example if perforate material or wire mesh is used this should be of adequate open area and suitable colour to permit viewing. Viewing will be enhanced if the perforate material is darker than the area observed.

5.11 Transparency

As far as is practicable, materials used for viewing machine operation shall be selected from amongst those which retain their transparency despite age and use. Guards shall be designed to make provision for the replacement of degraded materials.

Certain applications can require the selection of materials or combinations of materials that are resistant to abrasion, chemical attack, degradation by ultraviolet radiation, dust attraction by static electrical charge, or surface wetting by fluids which impair transparency.

5.12 Stroboscopic effects

Where there is a foreseeable hazard from stroboscopic effects, materials shall be selected which minimize this occurrence.

5.13 Electrostatic properties

Certain applications can require the election of materials that do not retain an electrostatic charge, in order to avoid an accumulation of dust and particles as well as sudden electrical discharge with the associated risks of fire or explosion.

Guards can need to be earthed to avoid build up of static charge to a hazardous level (see **JIS B 9960-1** : 1999).

5.14 Thermal stability

Materials shall be selected which do not degrade, that is which are not subject to brittle fracture, excessive deformation or emission of toxic or flammable fumes when exposed to the range of foreseeable temperature variations or sudden changes in temperatures.

Materials selected shall retain their properties in foreseeable climatic and workplace conditions.

5.15 Flammability

Where there is a foreseeable risk of fire, materials selected shall be spark resistant and fire retardent and shall not absorb or emit flammable fluid, fumes, etc.

5.16 Noise and vibration reduction

Where necessary, materials shall be selected to provide noise and vibration reduction. This can be achieved by means of insulation (putting an acoustic barrier in the path of the noise), and/or absorption (lining guards with appropriate acoustically absorbent materials) or by a combination of both. Guard panels can also need to be suitably damped to minimize effects of resonance which can transmit or amplify noise.

5.17 Radiation protection

In certain applications, such as welding or the use of lasers, materials shall be selected that protect persons from harmful radiation.

For welding applications, this protection can be by means of a suitably tinted transparent screen which permits viewing but eliminates harmful radiation (see Bibliography [6] and [8]).

6 Selection of types of guards

6.1 General

If the risk assessment has established a requirement for guards, they shall be selected in accordance with the following guidelines and Annex A (see also **JIS B 9700-2** : 2004, **5.2**).

In selecting suitable guards, the appropriate phases of the life of the machinery (as defined in **JIS B 9700-1** : 2004, **5.3**) shall be considered.

The most important selection criteria are:

— the probability and foreseeable severity of any injury as indicated by the risk assessment;

— the intended use of the machine as defined in **JIS B 9700-1** : 2004, **3.22**;

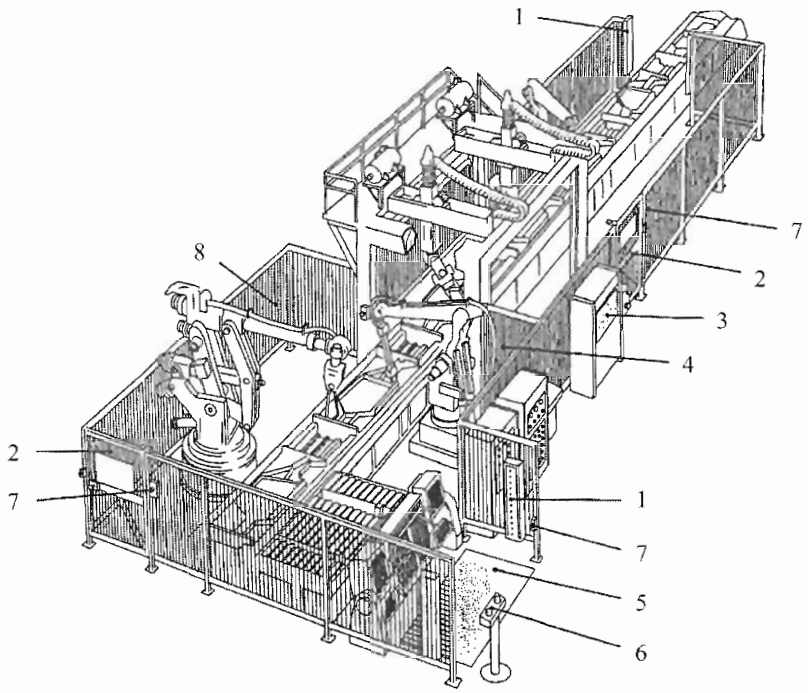
— the hazards present at the machine (see **JIS B 9700-1** : 2004, clause **4** and clause **5**);

— the nature and frequency of access.

6.2 Combination of different guards or of guards with other devices

It can be appropriate to use a combination of different types of guard. For example, if a machine has several danger zones and access is required to one of them during the operating phase, the guards can consist of a fixed guard combined with an interlocking movable guard.

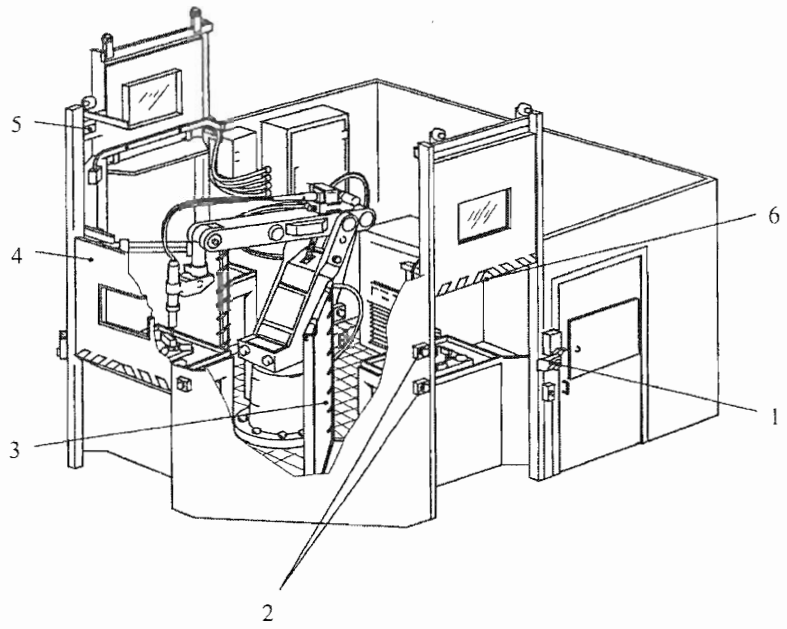
In a similar way, a combination of protective devices and guards can sometimes be required. For example, where a mechanical feed device is used in conjunction with a fixed guard to feed workpieces into a machine (thereby removing the need for access to the danger zone), a trip device (see **JIS B 9700-1** : 2004, **3.26.5**) can be required to protect against a secondary trapping or shearing hazard between the mechanical feed device and the fixed guard (see figures 9 and 10).



Key

1 Photo-electric curtain
2 Interlocking guard
3 Electrical cabinet
4 Internal fence allowing only sectional access
5 Pressure sensitive mat
6 Two-hand control device
7 Reset actuator
8 Distance guard

Figure 9 Example 1 of combination of different guards and guards with other protective devices



Key

1 Trapped key system
2 Two-hand control device
3 Screen between stations
4 Interlocking guard
5 Guard locking device
6 Pressure sensitive edge

Figure 10 Example 2 of combination of different guards and guards with other protective devices

6.3 Selection of guards according to the number and location of the hazards

Guards should be selected from the following in the order of priority given:

a) Local guards enclosing individual danger zones if the number of danger zones to protect is low. This can provide an acceptable residual risk and permits access to non-hazardous machine parts for maintenance, setting, etc.

b) A guard enclosing all the danger zones if the number or size of the danger zones is high. In this case, setting and maintenance points should, as far as possible, be located outside the guarded area.

c) Partial distance guard if the use of an enclosing guard is impracticable and the number of danger zones to protect is low.

d) Fully surrounding distance guard if the use of an enclosing guard is impracticable and the number of size of the danger zones are high.

The flow chart in Annex B illustrates this procedure.

It can be beneficial to the production process to divide a guarded area into different sections, to enable actions (for example checking, adjustment) in one section to be carried out without affecting machine operation in another section. In this case, the guarding for each section shall be in accordance with all the requirements of this Standard.

6.4 Selection of guards according to the nature and frequency of access required

NOTE : General principles for the selection of guards according to the nature and frequency of access are illustrated in Annex A.

6.4.1 Moving transmission parts

Guards to protect against hazards generated by moving transmission parts, for example pulleys, belts, gears, racks and pinions, shafts, shall be either fixed guards (see figure 1) or movable interlocking guards.

6.4.2 Where access is not required during use

Fixed guards should be used on account of their simplicity and reliability.

6.4.3 Where access is required during use

6.4.3.1 Where access is required only for machine setting, process correction or maintenance

The following types of guard should be used:

a) Movable guard if the foreseeable frequency of access is high (for example more than once per shift), or if removal or replacement of a fixed guard would be difficult. Movable guards shall be associated with an interlock or an interlock with guard locking (see **JIS B 9710** : 2006).

b) Fixed guard only if the foreseeable frequency of access is low, its replacement is easy and its removal and replacement are carried out under a safe system of work.

6.4.3.2 Where access is required during the working cycle

The following types of guard should be used:

a) Movable guard with interlock or with interlock with guard locking (see **JIS B 9710** : 2006). If access is required for a very short working cycle, it can be preferable to use a power-operated movable guard.

b) Control guard where the special conditions are met for use (see **5.4.9**).

6.4.3.3 Where, due to the nature of the operation, access to the danger zone cannot be totally prohibited

When tools, for example saw blades, need to partially exposed the following guards are appropriate:

a) Self-closing guard (see **5.4.6**);

b) Adjustable guard (see **5.4.7** and also **JIS B 9700-2** : 2004, **5.3.2.4**).

7 Additional design and construction considerations

7.1 Climbing

Climbing on guards shall, as far as practicable, be inhibited by design. Consideration shall be given to this possibility in their construction and the selection of materials and shapes. For example, by eliminating horizontal structural members and the horizontal component of mesh fabric from the outside surface of the guard, climbing is made more difficult.

7.2 Retained fastenings

Where practicable, guard fastenings shall remain attached to the guard, as this reduces the likelihood of their being lost and not replaced (see figure 11).

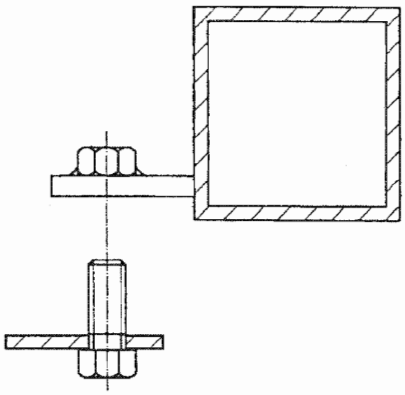


Figure 11 Example of a retained fastening

7.3 Vibration resistance

Where applicable, fastenings may need to be fitted with lock nuts, spring washers etc., to ensure that they remain attached to the guard.

7.4 Warning signs

Where access within the guarded area can expose persons to residual risks, for example radiation, appropriate warning signs shall be placed at access points.

7.5 Colour

Hazards can be highlighted by the use of suitable colours. For example, if a guard is painted the same colour as the machine and the hazardous parts painted a contrasting bright colour, attention is drawn to the hazard when the guard is opened or left off.

7.6 Aesthetics

As far as practicable, guards shall be designed so as to minimize adverse psychological effects.

8 Verification of the safety requirements for guards

8.1 General

Certain aspects of guard design and construction shall be subject to verification by examination, inspection, testing or calculation. Where practicable, verification shall be carried out with the guard in its working situation.

NOTE : For certain machines as specified in the Type-C standards, type testing of the guard is mandatory. In some instances, this can need to be carried out away from the machine, for example power take-off guards and guards for abrasive wheels.

8.2 Impact strength

Verification can be required for the resistance of guards to impact from persons, parts of tools, high pressure liquids, etc. Before carrying out this verification, it is necessary to identify the foreseeable impact hazard to which the guard may be subjected, for example low velocity impacts from persons, high velocity impacts from broken parts of tools, impact from high pressure fluids.

When verifying the impact strength of a guard, it is necessary to take account of the properties of the materials from which the guard is constructed. This shall include the strength of joints used and the strength of fixing points, slides, etc., by which the guard is attached to the machine or other structure.

Where Type-C standards are available, these shall specify the method of verification to be used.

8.3 Safety distances

Verification that guards comply with the required safety distances shall be by measurement (see **JIS B 9707** : 2002 and **JIS B 9708** : 2002).

8.4 Containment

Where guards are designed for containment of hazardous substances (see **5.1.3**), the performance of this function shall be verified. Where leakage is readily seen, visual inspection can be adequate. Where leakage cannot be seen, for example leakage of gas or vapour, an alternative verification method such as air sampling is required (see **JIS B 9709-1** : 2001).

8.5 Noise

Where a guard is designed to reduce noise, its acoustic performance shall be verified by taking noise readings.

8.6 Guard operating forces

Where normal usage of a guard involves the application of physical force, for example to open movable guards or to remove fixed guards, it may be necessary to verify that these forces are not excessive (see Bibliography [16]).

8.7 Visibility

Where the maintenance of visibility through the guard is essential to the proper functioning of the guard, this shall be verified under normal operating conditions by means of a visual check.

9 Information for use

9.1 General

The instructions for use shall contain the required information about guards and their functions, including installation and maintenance (see **JIS B 9700-2** : 2004, clause **6**).

9.2 Guard hazards

Information shall be provided of any hazards associated with the guards themselves, for example flammability of materials.

9.3 Installation

Instructions shall be supplied for the correct installation of guards and associated equipment.

9.4 Operation

Instructions shall be provided directing the user to the correct operation of the guards, their interlocks, etc. Warnings against reasonably foreseeable misuse shall be given (see **JIS B 9700-1** : 2004, **3.22**).

9.5 Removal of guards

Information shall be provided indicating any actions to be taken before guards may be removed safely, for example machine power isolation or dissipation of stored energy.

9.6 Inspection and maintenance

Details shall be provided of inspections to be carried out and maintenance required for, for example:

— loss of or damage to any part of the guard, especially where this leads to deterioration of safety performance, for example reduction of impact resistance from scratches to glazing materials;

— replacement of wearing parts;

— correct operation of interlocks;

— degradation of jointing or fixing points;

— degradation by corrosion, temperature change or chemical attack;

— satisfactory operation and lubrication, if necessary, of moving parts;

— modification of safety distances and aperture sizes;

— degradation of acoustic performance, if applicable.

Annex A (normative)
Guidelines to assist in the selection of guards against hazards generated by moving parts

The chart shown in figure A.1 shall be used in conjunction with clauses **4** and **6**. This Annex does not take the application of other protective devices, two-hand control devices etc. into account.

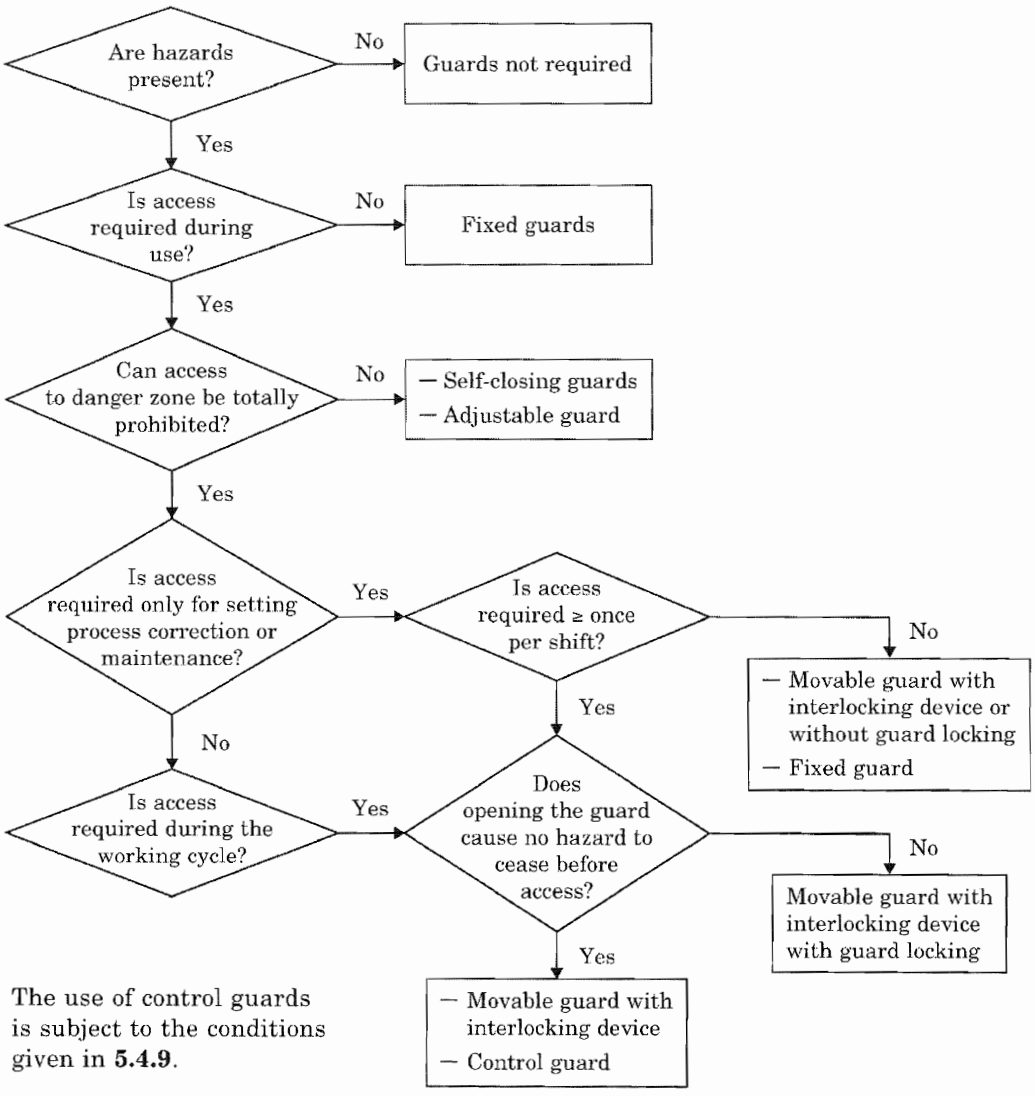


Figure A.1 Chart for the selection of guards against hazards generated by moving parts

Annex B (normative)
Guidelines for the selection of guards according to the number and location of hazards

The chart shown in figure B.1 shall be used in conjunction with causes **4** and **6.3**.

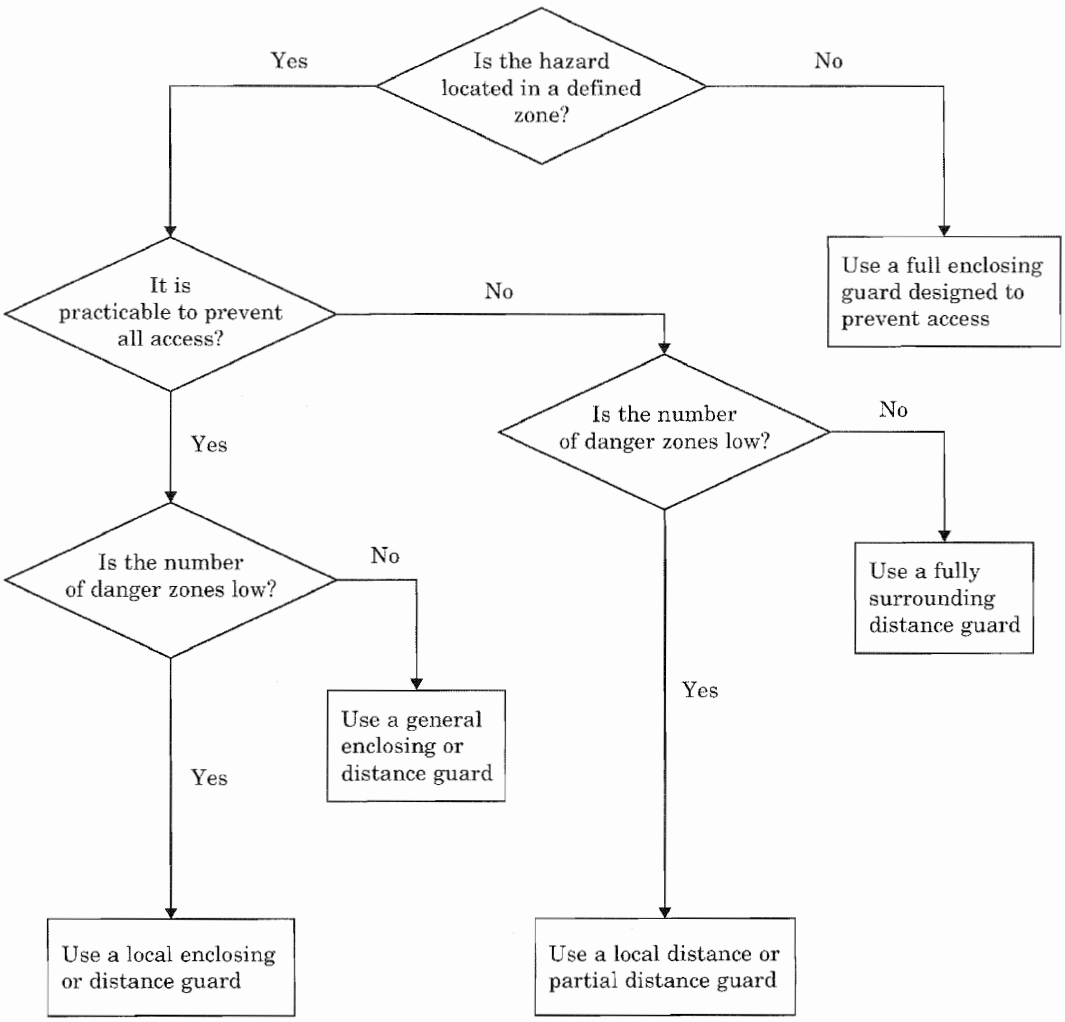


Figure B.1 Chart for the selection of guards according to the number and location of hazards

Bibliography

The Bibliography contains a list of International Standards, Japanese Industrial Standards and European Standards published or in preparation which can be helpful in the design and commissioning of guards.

Japanese Industrial Standards

[1] JIS Z 8736-1 : 1999 *Acoustics—Determination of sound power levels of noise sources using sound intensity—Part 1: Measurement at discrete points*

NOTE : Corresponding International Standard: **ISO 9614-1** : 1993 *Acoustics—Determination of sound power levels of noise sources using sound intensity—Part 1: Measurement at discrete points* (IDT)

[2] JIS Z 8736-2 : 1999 *Acoustics—Determination of sound power levels of noise sources using sound intensity—Part 2: Measurement by scanning*

NOTE : Corresponding International Standard: **ISO 9614-2** : 1996 *Acoustics—Determination of sound power levels of noise sources using sound intensity—Part 2: Measurement by scanning* (IDT)

International Standards

[3] ISO 3740 : 1980 *Acoustics—Determination of sound power levels of noise sources—Guidelines for the use of basic standards and for the preparation of noise test codes*

[4] ISO 11200 : 1995 *Acoustics—Noise emitted by machinery and equipment—Guidelines for the use of basic standards for the determination of emission sound pressure levels at a work station and at other specified positions*

[5] ISO 11253 : 1993 *Lasers and laser-related equipment—Laser device—Mechanical interfaces*

[6] IEC 60529 : 1989 *Degrees of protection provided by enclosures (IP-Code)*

European Standards published or in preparation

[7] EN 614-1 : 1995 *Safety of machinery—Ergonomic design principles—Part 1: Terminology and general principles*

[8] EN 1299 : 1997 *Mechanical vibration and shock—Vibration isolation of machines—Information for the application of source isolation*

[9] prEN 1672-1 : 1994 *Food processing machinery—Safety and hygiene requirements—Basic concepts—Part 1: Safety requirements*

[10] EN 1746 : 1998 *Safety of machinery—Guidance for the drafting of the "noise" clauses of safety standards*

[11] EN 1837 : 1999 *Safety of machinery—Integral lighting of machines*

[12] CR 1030-1 : 1995 *Hand-arm vibration—Guidelines for vibration hazards reduction—Part 1: Engineering methods by design of machinery*

[13] EN 1127-1 : 1998 *Explosive atmospheres—Explosion prevention and protection—Part 1: Basic concepts and methodology*

[14] EN 1672-2 : 1994 *Food processing machinery—Basic concepts—Part 2: Hygiene requirements*

[15] EN 292-2 : 1991/Amd 1 : 1995 *Safety of machinery—Basic concepts, general principles for design—Part 2: Technical principles and specifications*

[16] prEN 1005-3 : 1993 *Safety of machinery—Human physical performance—Part 3: Recommended force limits for machinery operation*

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